

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Fixed capacitors for use in electronic equipment –
Part 9: Sectional specification – Fixed capacitors of ceramic dielectric, Class 2**

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**Condensateurs fixes utilisés dans les équipements électroniques –
Partie 9: Spécification intermédiaire – Condensateurs fixes à diélectrique en
céramique, Classe 2**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –**Part 9: Sectional specification –
Fixed capacitors of ceramic dielectric, Class 2**

FOREWORD

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IEC 60384-9 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) The document has been completely restructured to comply with ISO/IEC Directives, Part 2 and to make it more useable; tables, figures and references have been revised accordingly. Annex X contains all cross-references of changes in clause/subclause numbers.
- b) The requirements of reference temperature 25 °C have been added in Table 7, Table 9, Table 11, Table 13 and Table 15.

- c) The table of temperature characteristics of capacitance for the reference temperature 25 °C have been added in Table B.1, Table B.2 and Table B.3.
- d) Annex B has been changed from informative to normative.
- e) Clause C.5 (Test schedule for quality conformance inspection) has been newly added to withdraw the blank detail specification: IEC 60384-9-1.

The text of this International Standard is based on the following documents:

Draft	Report on voting
40/3145/FDIS	40/3162/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60384 series, published under the general title *Fixed capacitors for use in electronic equipment*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 9: Sectional specification – Fixed capacitors of ceramic dielectric, Class 2

1 Scope

This part of IEC 60384 is applicable to fixed capacitors of ceramic dielectric with a defined temperature coefficient (dielectric Class 2), intended for use in electronic equipment, including leadless capacitors but excluding fixed surface mount multilayer capacitors of ceramic dielectric, which are covered by IEC 60384-22 (Class 2).

Capacitors for electromagnetic interference suppression are not included, but are covered by IEC 60384-14.

The object of this document is to specify preferred ratings and characteristics and to select from IEC 60384-1:2021 the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of capacitor. Test severities and requirements specified in detail specifications referring to this document provide specific test severities and requirements of an equal or higher performance level. Further information on the conception of generic, sectional and detail specifications can be found in the Introduction of IEC 60384-1:2021.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60384-1:2021, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

IEC 61193-2:2007, *Quality assessment systems – Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60384-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 capacitor of ceramic dielectric, Class 2

capacitor which has a dielectric with a high permittivity and is suitable for by-pass and coupling applications or for frequency discriminating circuits where low losses and high stability of capacitance are not of major importance

Note 1 to entry: The ceramic dielectric is characterized by the non-linear change of capacitance over the category temperature range (see Table 2).

3.2 subclass

<Class 2> maximum percentage change of capacitance within the category temperature range with respect to the capacitance at the reference temperature 20 °C or 25 °C

Note 1 to entry: The subclass may be expressed in code form (see Table 2 and Annex B).

3.3 rated voltage

U_R

maximum DC voltage that can be applied continuously to the terminations of a capacitor at the rated temperature

Note 1 to entry: Maximum DC voltage is the sum of the DC voltage and peak AC voltage or peak pulse voltage applied to the capacitor.

4 Preferred ratings and characteristics

4.1 Preferred characteristics

Preferred climatic categories only shall be given in the preferred characteristics.

The capacitors covered by this document are classified into climatic categories in accordance with the general rules given in IEC 60068-1:2013, Annex A.

For a reference temperature of 20 °C, the lower and upper category temperatures and the duration of the damp heat, steady state test shall be chosen from the following:

- | | |
|--|--|
| – lower category temperature: | –55 °C, –40 °C, –25 °C and –10 °C |
| – upper category temperature: | +70 °C, +85 °C, +100 °C, +125 °C and +150 °C |
| – duration of the damp heat, steady state test (40 °C, 93 % RH): | 4 days, 10 days, 21 days, and 56 days |

For a reference temperature of 25 °C, the lower and upper category temperatures shall be chosen from Table B.1 in Annex B.

The severities for the cold and dry heat tests are the lower and upper category temperatures, respectively.

4.2 Preferred values of ratings

4.2.1 Rated temperature

For capacitors covered by this document, the rated temperature is equal to the upper category temperature.

4.2.2 Rated voltage (U_R)

The preferred values of rated voltage are: (25, 40, 63, 100, 160, 250, 400, 630, 1 000, 1 600, 2 500, 4 000 and 6 300) V. These values conform to the basic series of preferred values R5 given in ISO 3. If other values are needed, they shall be chosen from the R10 series. The sum of the DC voltage and the peak AC voltage or the peak to peak AC voltage, whichever is the greater, applied to the capacitor shall not exceed the rated voltage.

4.2.3 Category voltage (U_C)

Since the rated temperature is defined as the upper category temperature, the category voltage is equal to the rated voltage, as defined in IEC 60384-1:2021, 3.5.

4.2.4 Preferred values of nominal capacitance and associated tolerance values

4.2.4.1 Preferred values of nominal capacitance

Nominal capacitance values should be taken from the E3, E6 and E12 series given in IEC 60063.

4.2.4.2 Preferred tolerances on nominal capacitance

Table 1 denotes the preferred values of tolerance on nominal capacitance.

Table 1 – Preferred tolerance on nominal capacitance

Preferred series	Tolerances %	Letter code
E3 and E6	-20/+80	Z
	-20/+50	S
E6	±20	M
E6 and E12	±10	K

4.2.5 Temperature characteristic of capacitance

Table 2 shows the temperature characteristic with and without DC voltage applied for the reference temperature 20 °C. The method of coding the subclass is also given; for example, a dielectric with a percentage change of ±20 % without DC voltage applied over the temperature range from -55 °C to +125 °C, will be defined as a dielectric of Class 2C1. The temperature characteristics, category temperatures and corresponding codes for the reference temperature 25 °C are given in Annex B.

The temperature range, for which the temperature characteristics of the dielectric is defined, is the same as the category temperature range.

Table 2 – Temperature characteristic of capacitance

Sub-class letter code	Maximum capacitance change within the category temperature range with respect to the capacitance at 20 °C measured with and without a DC voltage applied %		Category temperature range and corresponding number code					
			-55/+150 °C	-55/+125 °C	-55/+85 °C	-40/+85 °C	-25/+85 °C	+10/+85 °C
	without DC voltage applied	with DC voltage applied ^a	0	1	2	3	4	6
2B	±10	Requirements specified in the detail specification						
2C	±20							
2D	+20/-30							
2E	+22/-56							
2F	+30/-80							
2R	±15							
When the upper category temperature is above 125 °C, the limits of capacitance change, both with and without DC voltage applied, should be given in the detail specification.								
^a DC voltage applied is either rated voltage or the voltage specified in the detail specification.								
NOTE Annex B can be referred to for preferred values of the temperature characteristics for the reference temperature 25 °C.								

5 Test and measurement procedures

5.1 General

This Clause 5 supplements the information given in IEC 60384-1:2021, Clause 5 to Clause 10.

5.2 Special preconditioning

Unless otherwise specified in the detail specification, the special preconditioning, when specified in this document before a test or a sequence of tests, shall be carried out under the following conditions: exposure at upper category temperature or at such higher temperature as may be specified in the detail specification for a period of 1 h, followed by recovery for a period of 24 h ± 1 h at standard atmospheric conditions for testing.

NOTE Class 2 capacitors lose capacitance continuously with time following a logarithmic law (this is called ageing). However if the capacitor is heated to a temperature above the Curie point of its dielectric then "de-ageing" takes place, i.e. the capacitance lost through "ageing" is regained, and "ageing" recommences from the time when the capacitor recools.

The purpose of special preconditioning is to bring the capacitor to a defined stage regardless of its previous history (see Clause A.4 for further information).

5.3 Visual examination and check of dimensions

See IEC 60384-1:2021, 7.1.

5.4 Electrical tests

5.4.1 Capacitance

5.4.1.1 General

See IEC 60384-1:2021, 6.3, with the details of 5.4.1.2 and 5.4.1.3.

5.4.1.2 Measuring conditions

The capacitance shall be measured in accordance with Table 3 and in accordance with the details given below Table 3.

Table 3 – Measuring conditions

Reference temperature	Subclass	Measuring voltage	Referee voltage ^a
20 °C	2B, 2C, 2X	1,0 ± 0,2 V	1,0 ± 0,02 V
	2D, 2E, 2F, 2R	0,3 ± 0,2 V or as specified in the detail specification	0,3 ± 0,02 V or as specified in the detail specification
25 °C	R,S,T,U	1,0 ± 0,2 V	1,0 ± 0,02 V

^a In case of dispute about results of measurements, referee voltage is applied.

Frequency: $C_N < 100 \text{ pF}$ $f = 1 \text{ MHz}$ unless otherwise specified in the detail specification.

$C_N \geq 100 \text{ pF}$ $f = 1 \text{ kHz} \pm 20 \%$ for measuring purposes and 1 kHz for referee tests.

$C_N > 10 \text{ }\mu\text{F}$ $f = 100 \text{ Hz}$ or $120 \text{ Hz} \pm 20 \%$ with measuring voltage $0,5 \text{ V} \pm 0,2 \text{ V}$ for measuring purposes and 100 Hz or 120 Hz for referee tests.

5.4.1.3 Requirements

The capacitance value shall correspond with the rated value taking into account the specified tolerance.

For referee measurements the capacitance value shall be the value extrapolated to an ageing time of 1 000 h, unless otherwise specified in the detail specification (for explanation see Annex A).

5.4.2 Tangent of loss angle ($\tan \delta$)

5.4.2.1 General

See IEC 60384-1:2021, 6.4, with the details of 5.4.2.2 to 5.4.2.4.

5.4.2.2 Measuring conditions

See 5.4.1.

5.4.2.3 Accuracy

The accuracy of the measuring instruments shall be such that the measuring error does not exceed 0,001.

5.4.2.4 Requirements

The tangent of loss angle shall not exceed 0,035, or such lower value as may be given in the detail specification.

5.4.3 Insulation resistance (R_i)

5.4.3.1 General

See IEC 60384-1:2021, 6.1, with the details of 5.4.3.2 and 5.4.3.3.